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PRIMARY INSECTS RESPONSIBLE FOR THE DYING CONDITION OF INCENSE CEDAR IN THE BASS LAKE REGION OF CALIFORNIA

by
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U. S. DEPARTMENT OF AGRICULTURE
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PRIMARY INSECTS RESPONSIBLE FOR THE DYING CONDITION OF INCENSE CEDAR IN THE BASS LAKE REGION OF CALIFORNIA.

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Incense cedar in the hills surrounding Bass Lake at the present time is in a poor state of health due to insect attack. Nearly every tree in the vicinity shows some sign of injury, in the form of top killing, scattered dead branches and dead twigs. In addition, numerous trees have been killed outright, some of which have recently faded, others with reddish foliage indicating a previous year's killing, and still a third group, those in which the foliage is entirely gone, stand as bare snags. This progressive killing would indicate several seasons of attack by insect pests.

Certain localities are suffering more heavily than others, as is indicated by the fact that more dead trees and numerous injuries in the live trees are found on the south and west slopes adjoining the north east end of Bass Lake, where conditions appear much drier and exposed.

It is the purpose of this paper to give an account of the damage done, the type of damage and the insects apparently involved as the primary factors. As only six weeks were spent in this study, it may readily be seen that this account must necessarily be brief, and due to the lack of sufficient evidence, somewhat incomplete.

CAUSES OF INJURY

To find the insect responsible for various types of injury in the Incense Cedar is not always easy, on account of the interlocking relations of the insects concerned. One insect may be the factor causing all the types of injury, while in other cases there may be a number of different families that play a part in contributing to the death of the tree attacked.

A species of Phloeosinus may be the only insect attacking a tree, in which case the tree usually shows quite characteristic sympthos, the extent of which depends upon the extent of the attack. The results of the attack of this insect depend to a large degree on the size, rate of growth, state of health and general growing conditions of the tree. The usual signs indicating an attack by Phloeosinus are scattered fading branches or top kill, caused in two ways, depending on the size of the branches. The first is caused by a peculiar feeding habit of the adult insect. In this case the twigs are mined for as much as an inch in some cases, the insect apparently entering the branch from the under side and working toward the main trunk. The twig so mined usually lops down in a characteristic manner and fades. Some of the larger twigs or smaller branches are able to withstand such feeding attacks and show only the rough, scarred appearance without succumbing.

This is not the most destructive habit of Phloeosinus however, for it is in its breeding habits that the insect endangers the life of the tree that it attacks. In this case, the adult insect bores into the sapwood of the tree and forms an egg chamber that is the

starting point of large numbers of larval mines. In a young tree, if the tree is not girdled by the egg gallery, it stands a very good chance of being girdled by these larval galleries. In the larger trees, where the circumference is greater than the length of the larval mines or the egg gallery, the single attack may have no very drastis results, but in cases where there may be other attacks and a larger brood, it will cut off the nourishment of the tree. Some large trees are known to have withstood the attacks of this insect for a number of years, and then finally died from the combination of the yearly attacks.

CAUSES OF DEATH

The cause of death of Incense Cedar in the Bass Lake region is in the majority of the cases due to Semanotus amethystinus (Lec.), a large cerambycid confined largely to the Pacific Coast states, on Incense Cedar It is a large black insect with a bright blue-violet elytra. It mines the inner bark and sapwood of the tree, destroying the cambium. The size of the larva of this insect insures a thorough job of girdling when a tree is attacked. The eggs are laid in the crevices of the bark and when hatched the larvae work their way into the sapwood and proceed to make long winding galleries, extending in some cases as much as three feet along the tree. Fortunately most of these burrows extend with the grain of the wood and thus are not so likely to cause death to the tree as they would, should they work around the circumference of the tree. Even so, the attacks of this insect are a great menace to the cedar in this region, due to the fact that a large number may attack a single tree and thus by force of numbers riddle the base of the tree to such an extent as to kill the tree in a single season. In most cases the largest numbers of larvae are found in the tree from the ground up to ten feet. After that they are more scattered, although there is no point above which it may be said that no more will occur. There are a number of places on the tree which are acceptable to the insects for pupation. On most of the larger trees where the bark was sufficiently thick to allow them to do so, the larvae construct a pupation chamber in the outer bark; however, in other cases, where the bark was not so thick, pupation chambers were constructed between the sapwood and the bark.

The third position found was in the heartwood of the tree. In this case the larva bores to the center of the tree and constructs the gallery in essentially the same manner as in the other cases. When they go into pupation, they are always pointing toward the entrance of the chamber in order that they do not have to bore their way out through the wood but merely crawl out through the frass left behind in the formation of the tunnel. They must, however, cut through the soft outer bark. As in Phloeosinus, there is no sure method of determining their work without examination. In some cases the trees attacked show a top kill or in others the whole tree may be faded. The emergence holes are the best evidence of the attack but due to the fact that they leave no marks when they enter a tree, it may be killed before it is known to be attacked.

These insects are attracted in numbers to trap trees, indicating that these insects are also secondary. This view was confirmed upon examination of trees that had been killed for two or more years. Since this insect is not averse to attacking trees that have been dead for

some time, it seems likely that the trees which are attacked are in a weakened condition before the attack takes place. The reason for this condition is probably one of moisture. Since most of the trees observed were on a slope it seems likely that the runoff was responsible for the lack of soil moisture. There is probably a porous soil in that particular region as well, allowing escessive percolation of the water and a consequent dry condition in the soil. This condition would make it favorable for other insects, usually secondary to make an attack on living trees.

INSECTS OF SECONDARY IMPORTANCE

Other insects apparently of secondary importance in Incense Cedar are quite numerous. Records showed that of the family Buprestidae, Chrysobothris nix e H rn and Chrysobothris viridicyanea Horn were both taken, attracted to the felled trees. Some evidences were also found indicating that trees had been attacked either when in a weakened condition or shortly after death. It does not seem likely that these insects are responsible for the death of many trees in this region unless the trees were sufficiently far gone so as to be unable to resist the infestation. This condition is possible from the drought conditions that have existed in this area.

Chrysobothris nixa Horn was taken from pupal chambers of a number of dead trees that had been killed the previous year. They were also taken mating and ovipositing on the logs of the trap trees. This fact coupled with the fact that they were taken from their pupap chambers prove that they are in the habit of using Incense Cedar, as their host tree. Just when they attack is somewhat difficult to ascertain, but it is very probable that if the conditions were favorable, they would not hesitate to attack a living tree.

Callidium antennatum Newn. was also taken, attracted to the trap trees but less frequently than Semanotus ligneus (Fabr) which appeared in great numbers and flew for a short time, (about 15-30). There was no evidence that this insect attacked living trees and from the fact that on May 16 individuals were seen ovipositing and one month later, June 19, young larvae were found working at the same spot on a fading tree that had been felled May 11, it was assumed that they were entirely secondary.

Phymatodes nitidus (Led. a shining dark brown insect with conspicuous yellow bands on its elytra was taken from its pupal cell in the branches of the cedars and was also taken in flight, attracted to the trap trees. These insects are rather small in size, being about six or seven millimeters long. They are probably not abolutely secondary but may enter a tree where there has been some previous injury, as small branches killed by Phloeosinus, or broken by snow, etc.

At least three species of Hymenopterous Insects were taken from their burrows in the trunks of the trees but their part in killing the tree is negligible.

Other insects and larvae that were found under the bark and in the galleries of the primary insects included Temnochila virescens (Fabr), a predaceous form that was often found attacking the larvae of Semanotus amethystinus (Lec.) A Raphidid larva was also found very commonly, usually under the outer scales of the bark. Of the other insects found that were either predaceous or merely scavengers, there were numerous small staphylinid beetles and one species of robust carabid. There were two types of chrysomelid beetles taken from the branches and leaves, presumably defoliators, although their work was not noticeable.

FIELD NOTES

Series I --- Trees not yet dead but fading
Tree I --- Felled May 11, 1933.
Height --- 50'
Diameter Breast height - 14"
Annual rings in last inch - 18
Foliage fading. Heartwood stained for about 15 feet. Tree about 60% girdled by flathead and roundhead work. Work extending from base to about twenty feet. About 90% of the limbs show Phloeosinus work.
May 25 - Semanotus ligneus (Fabr.) taken in capulation. Chrysobothris nixa Horn seen resting on log. Chrysobothris viridicyanea Horn seen on a smaller limb. Callidium antennatum Newm. taken at tree. Phloeosinus sp. taken on tree and in flight.
June 19, New Cermabycid larvae at work - probably Semanotus ligneus (Fabr.(

Series I
Tree 2 --- Felled May 16
Height --- 50"
D.B.H. --- 14"
Annual rings in last inch --,36.
Foliage fading, top still green.
Stem analysis -- Base to thirty feet, Cermabycid attacks with well grown larvae at work. Few exit holes. Base almost completely girdled. Twenty-five to thirty feet, Phloeosinus sp. attacks which were unsuccessful. Thirty feet to top -- Phloeosinus larvae, pupae and adults at work. Numerous exit holes present along trunk and limbs. Cerambycid and Buprestid work in trunk up to twenty five feet. Scars where emergence occurred. June 19 - Mature Phloeosinus larvae, also pupae.

Series I
Tree 3 --- Felled May 20
Height 95'
D.B.H. 30"
Annual rings in last inch -- 48
Foliage fading
Stem analysis - Killed by Semanotus amethystinus (Lec.) Mature larvae and adults found at base. Some larvae had been eaten by larvae of Temnochila virescens (Fabr.) which were found in the pupal chambers and galleries. Exit holes of Cerambycids were quite numerous extending along trunk for entire length. Phloeosinus larvae found at work on trunk at thirty feet from base. Limbs all slowed phloeosinus work to some extent. Prepupal and mature Cerambycid larvae found in pupal chambers from base to seventy feet. New adults ready for emergence found from base to thirty feet. The infestation seemed more intense at

the base where there were numerous larvae and adults. As the height increased the number of adults in proportion to the number of larvae decreased until at thirty feet the last adult was found. There were a few emergence holes above this point from the previous year. From thirty to sixty feet few Cerambycid larvae were found but flathead work made its appearance, extending to within a few feet of the top. No larvae or adults were found. Semanotus amethystinus (Lec) found pupating in heartwood.

Series I
Tree 4 -- Felled May 20
Height 80'
D.B.H. 26"
Annual rings in last inch -- 45
Foliage faded with scattered green branches. This tree was probably struck by lightning in the past. Heavy Semanotus work noted in the scar. Otherwise light work from base to sixty feet. A change was noted in the place of pupation when the diameter of the trunk and the thickness of the bark were decreased. Typical Semanotus work beginning at about fiftyfive feet and extending upward for about three feet terminated, instead of in the bark, as is usually the case, in a pupal chamber located just under the sapwood in the heartwood. As is usually the case, the pupal chamber extended downward from the end of the entrance gallery and was sufficiently large to allow the larva to turn around and pupate with its head toward the top of the tree, facing the exit. The branches of this tree were sparse and largely faded due to the small amount of green cambium remaining. The branches had a light infestation of Phloeosinus sp. but not sufficient to cause death.

Series II Trees entirely faded.
Tree #1. Felled May 11.
Height 35'
D.B.H. 17"
Annual rings in the last inch 12
Stem analysis -- Limbs retaining faded foliage. Flat-head work very much in evidence. Phloeosinus work riddling the top of the tree and limbs. Cerambycid work present but not serious. June 13. One specimen of Callidium antennatum Newm. taken dead from pupal chamber. Numerous horntail emergence holes in evidence.

Series II
Tree #2 Felled May 20
Height 87'
D.B.H. 28"
Annual rings in the last inch - 30,
Stem analysis -- The foliage of this tree was red. The trunk shows woodpecker work to quite an extent, extending from the base to the top. Cerambycid emergence holes are quite numerous. Light Phloeosinus work is evident on nearly all the branches, heavy work on some. There were emergence holes on all branches affected. In about 30% of the cases the infestation was sufficient to kill the branches outright and in the others the branches were merely weakened.

Flathead larvae about one half inch long were found mining the branches in the upper half of the crown. As these branches were also affected by Phloeosinus there was a combination of factors entering into the killing of the branches so affected. In one branch a small cerambycid, Phymatodes nitidus Led. was taken from a pupal cell. Other beetles of the same species had been attracted

to trap trees or other freshly felled cedar.

The last twenty feet of the trunk showed a heavy infestation of flatheads probably Chrysobothris nixa, as several segments were found.

In the stump numerous prepupal larvae and new adults of Semanotus amethystinus (Lec.) were taken.

From the base cut to forty feet was light Cerambycid work and from forty feet to the top was Buprestid work, from moderate to heavy in spots.

Scattered along the trunk were exit holes of at least two species of Hymenopterous wood boring insects, the adult emerging at the time of examination. (May 31, 1933.)

In the upper portion of the tree the cerambycid larvae made their pupal chambers in the heartwood instead of in the bark as they do normally. Buprestid pupae were found in their chambers in the sapwood.

Series III Trees mostly green with scattered fading branches or top killed.

Tree #1 Felled May 16, 1933.
Height 65'
D.B.H. 21"
Annual rings in the last inch 19
Stem analysis: Foliage green to fifty feet, sorrel to black at top. Apparently killed by flatheads at forty five feet. Stem completely girdled at that point.

Cerambycid work on the trunk from base to about forty feet. No apparent damage except weakening the tree and allowing further insect attack. Phloeosinus work on trunk and limbs and trunk from 40 feet to top with numerous emergence holes, indicating several years of attack. New attacks being made at bases of green branches.

Series III
Tree #2. Felled May 11, 1933.
Height 65'
D.B.H. 15"
Annual rings in the last inch - 38
Stem analysis --- Foliage green with a small percentage of fading branches. Base cut shows no insect work of any kind. Limbs show some signs of Phloeosinus attack.

May 25 - Phloeosinus observed walking about on the surface of the trunk about three feet from the top, also taken from the branches and in flight near the tree.

Semanotus ligneus (Fabr.) taken on main trunk.

June 13. Numerous Semanotus amethystinus (Lec.) taken in copulation and ovipositing.

Series III
Tree #3 Felled May 20, 1933.

Height 57'
D.B.H. 16"
Annual rings in the last inch. 20
Stem analysis - Foliage green with a few faded branches. Limbs show signs of Phloeosinus work. No cerambycid or Buprestid work noted. Specimen of Semanotus amethystinus (Lec.) collected June 9, attracted to tree. Numerous Buprestids noted on trunk and branches.

Several ostomids, Temnochila virescens (Fabr.) were noted, apparently attracted to the tree. There were some Phloeosinus attacks made at the bases of the branches.

Series III
Tree #4.
Height 58'
D.B.H. 17"
Annual rings in the last inch - 45

Stem analysis - Foliage green with scattered lading branches. Branches show Phloeosinus work to quite an extent, sufficient in some cases to girdle and kill the limbs. There was Cerambycid work from the stump to twenty feet with the pupal cells sometimes in the bark and at other times in the heartwood. There was no infestation of Phloeosinus on the trunk unless at the base of the branches.

Series III
Tree 5
Height 20'
D.B.H. 8"
Rings in the last inch - 24
Stem analysis - Foliage green with numerous faded branches. Attacked by Phloeosinus. Base to 6 feet free from insect work. Six to fourteen feet, heavy attack of Phloeosinus on the trunk working in the phloem, reducing the thickness in places to one half the normal thickness. Ninety percent of the branches between six and fourteen feet attacked by Phloeosinus. About sixty percent of those attacked dead or fading. From fourteen feet to the top free from insect attack. Phloeosinus taken from the tree May 11, 1933. Undescribed species of scale taken from bark, on limbs and trunk.

Series III
Tree 6.
Height 38'
D.B.H. 15'
Annual rings in the last inch - 46
Stem analysis - Foliage green with scattered faded branches. Base to twenty feet, Cerambycid work partially girdling trunk. Limbs attacked and a large percentage killed. Heavy infestation found at base getting lighter toward the top of infested area. No Phloeosinus infestation on the main trunk but quite heavy on the lateral branches.

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